Atmospheric Aerosol Source-Receptor Relationships:
The Role of Coal-Fired Power Plants

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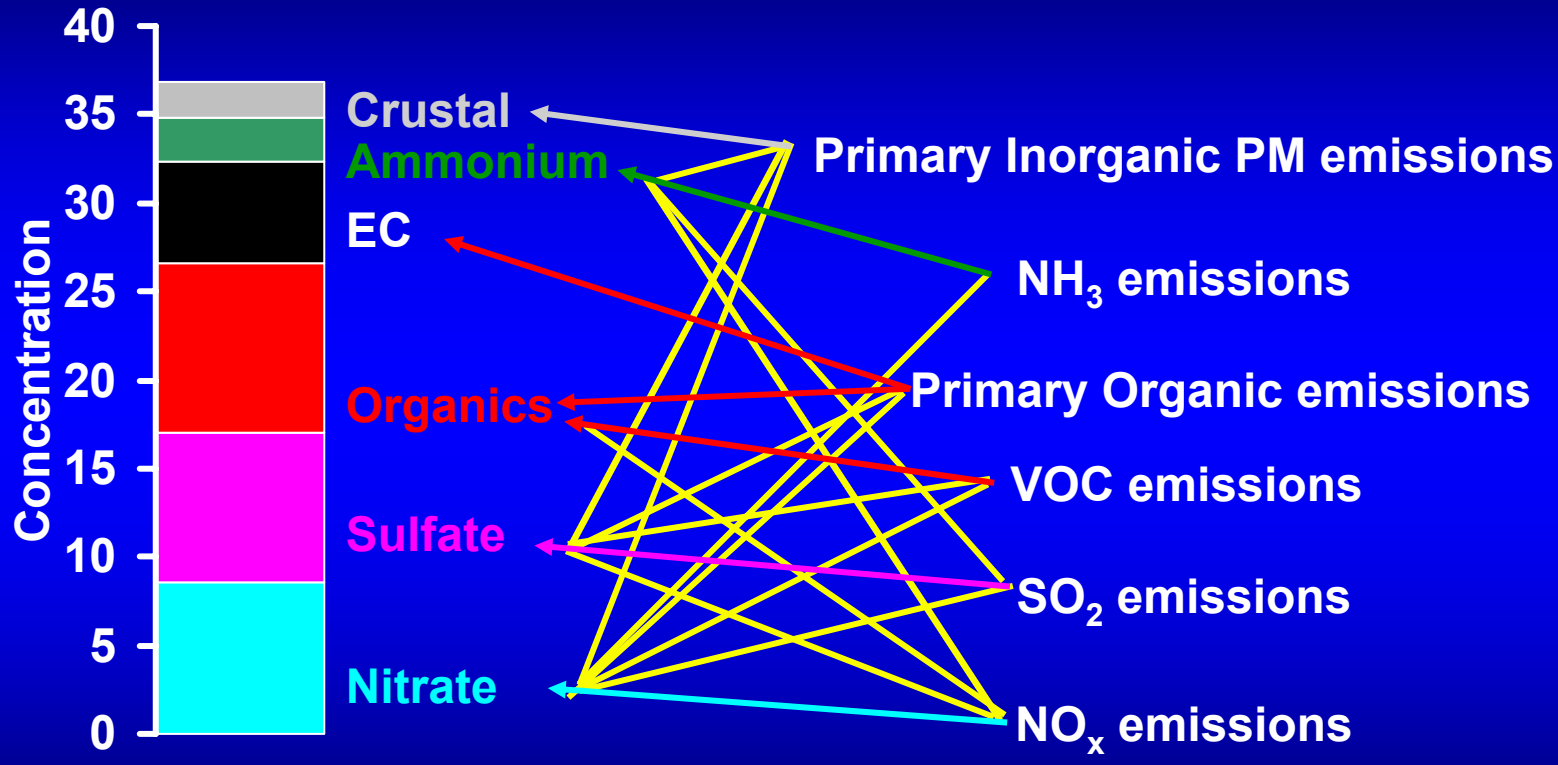
The Source-Receptor Challenge: Interactions between Fine PM and Their Precursors



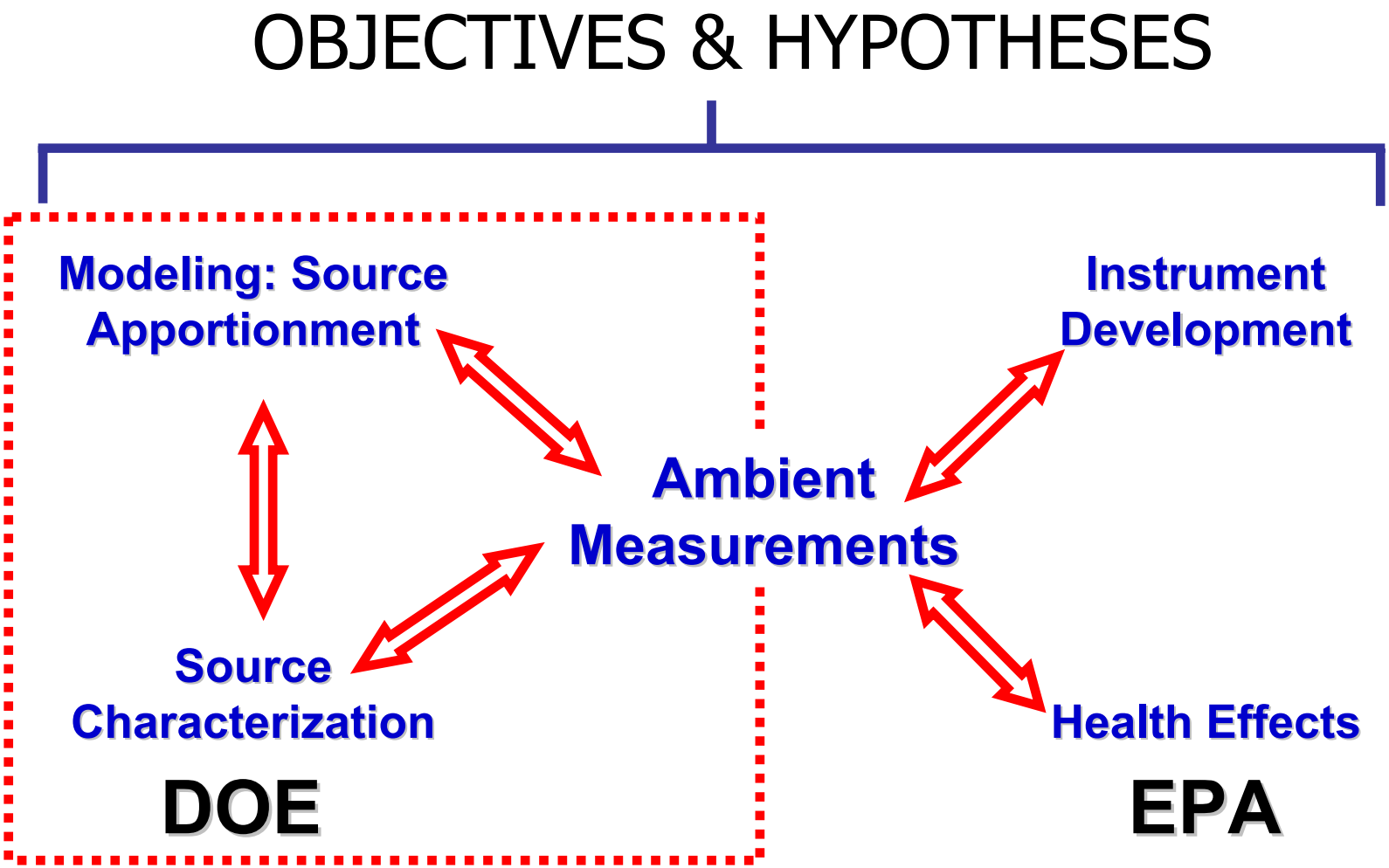
$PM_{2.5}$ Composition during the Winter

Study Objectives

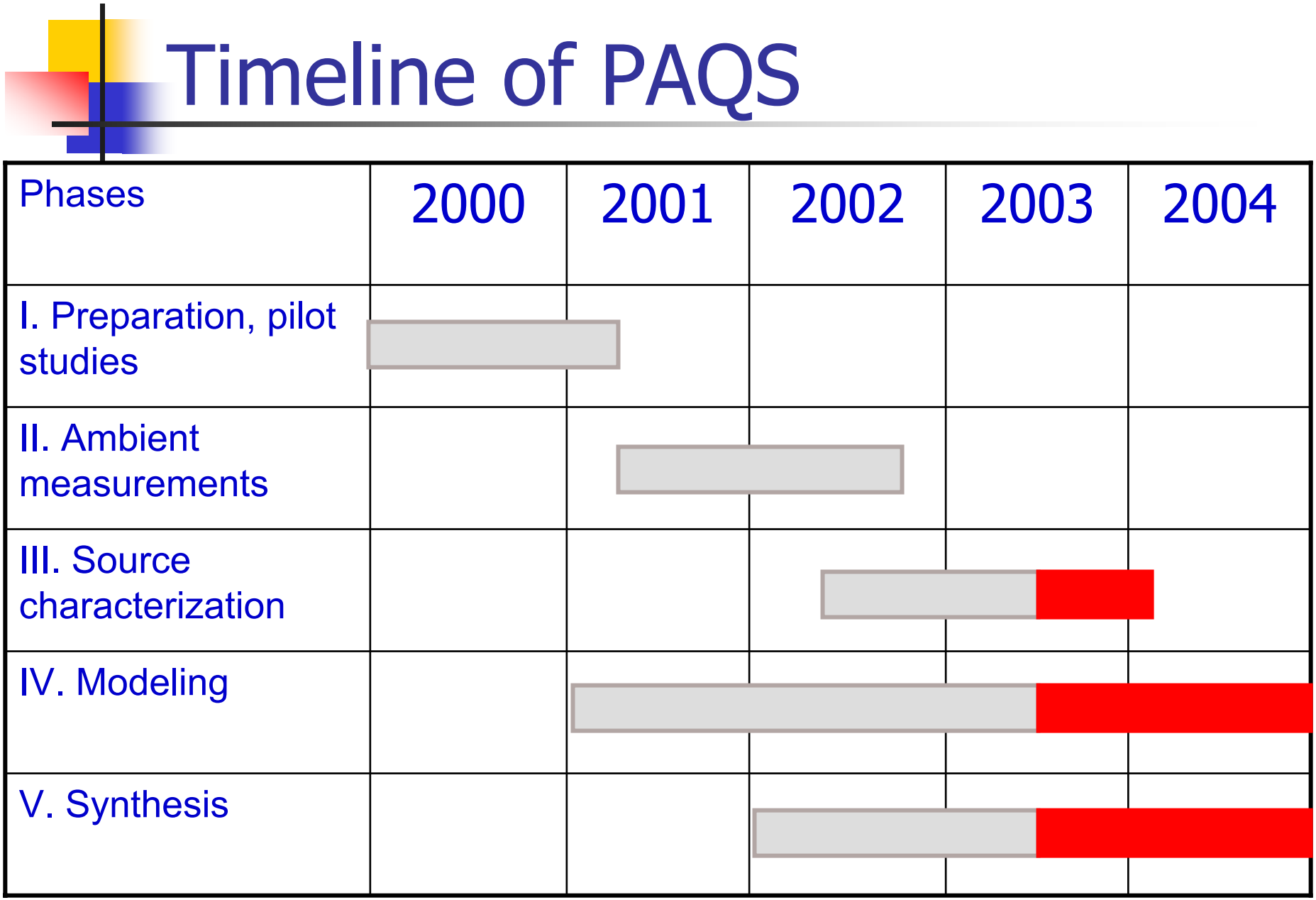
Use the Pittsburgh area as a laboratory to:

- Develop and evaluate the next generation of atmospheric PM monitoring techniques (real time single particle measurements, ultrafine PM, organics, continuous, etc.)
- Improve our understanding of the physical and chemical properties of fine PM
- Characterize the major pollution sources in the area taking advantage of the new measurement techniques
- Quantify the impact of the various sources (power plants, transportation, biogenic, etc.) to the fine PM concentrations in the area
- Quantify the responses of PM to changes in emissions

The Pittsburgh Air Quality Study (PAQS)



Timeline of PAQS



Presentation Outline

- Introduction to PAQS
- Fine aerosol mass concentration and composition
- Inorganic aerosol component characterization
- Organic aerosol components
  - Primary and secondary organics
- Source characterization
- Source attribution
- Modeling
  - Sulfate-nitrate interactions
  - 3D Chemical Transport Model
- Nucleation and ultrafine particles
- Conclusions and future work

PAQS Team Members

- S. Pandis, C. Davidson, A. Robinson [CMU] **(NSM distributions, ions, metals, ozone, NOx, HNO_3, NH_3, VOCs, size-resolved measurements)**
- A. Wexler, M. Johnston, [UC Davis, U. Delaware] **(Single particle mass spectrometry, organic aerosols, aerosol water)**
- W. Rogge [Florida Int.] **(Organic speciation)**
- B. Turpin [Rutgers] **(OC/EC, FTIR, organic characterization)**
- S. Hering [Aerosol Dynamics] **(Semi-continuous nitrate, sulfate, carbon)**
- D. Worsnop [Aerodyne] (AMS)
- D. Eatough [BYU] **(Organic/Inorganic sampling)**
- J. Ondov, S. Buckley, B. Doddridge [U. Maryland] **(Semi-continuous metals, upper air measurements)**
- J. Jimenez, M. Hernandez [U. Colorado] **(AMS, Bioaerosols)**
- J. Collett [Colorado State] **(Peroxides, fogwater)**
- U. Baltensperger [Paul Sherrer Inst.] **(Surface area)**
- A. Goldstein [UC Berkeley] **(Semi-continuous VOCs)**
- RJ Lee **(Morphology, coarse single particle analysis)**

Graduate Students Trained

- Natalie Anderson
- Juan Cabada
- Kathleen Fahey
- Timothy Gaydos
- Bonyoung Koo
- Eric Lipsky
- Mulia Mandiro
- Andrea Polidori
- Sarah Rees
- Bhavesh Shah
- Charles Stanier
- Satoshi Takahama
- Wei Tang
- Timothy Raymond
- R. Subramanian
- Emily Weitkamp

- Twelve undergraduate students
- Visiting researchers (Brazil, Denmark, Greece, Italy, Switzerland)

Peer-Reviewed Publications (1)

PM SOURCES

1. Cabada et al. (2002) Sources of atmospheric particulate matter in Pittsburgh, Pennsylvania, JAWMA, 52, 732-741.
2. Stanier et al.(2002) Chemical processes and long-range transport of aerosols: Insights from the Pittsburgh Air Quality Study, in *Long Range Transport of Air Pollution,* Kluwer.
3. Zhou et al. (2003) The Advanced Factor Analysis on Pittsburgh particle size distribution data, *Aerosol Sci. Technol.,* (in press).
4. Eatough et al. (2003) Source apportionment of PM2.5, organic material and sulfate during the July 2001 summer intensive (to be submitted).
5. Zhou et al. (2003) Source apportionment using particle size distribution data from PAQS (to be submitted).
6. Gaffney et al. (2003) Natural radionuclides in fine aerosols in Pittsburgh (to be submitted).

Peer-Reviewed Publications (2)

ORGANIC AEROSOL

7. Cabada et al. (2003) Estimating the secondary organic aerosol contribution to PM2.5 using the EC tracer method, *Aerosol Sci. Technol.,* (in press).
8. Subramanian et al. (2003) Measurement of ambient carbonaceous aerosols during the Pittsburgh Air Quality Study, *Aerosol Sci. Technol.,* (in press).
9. Subramanian et al. (2003) Examining the assumptions behind elemental carbon measurements using the thermal-optical transmittance technique, (to be submitted)
10. Rogge et al. (2003) Organic PM2.5 at the Pittsburgh Supersite: Regional versus local concentrations and seasonal variations (to be submitted).

Peer Reviewed Publications (3)

PM CHARACTERIZATION

11. Wittig et al. (2003) The Pittsburgh Air Quality Study: An Overview, *Atmos. Environ.* (submitted).
12. Stanier et al. (2003) Aerosol size distribution climatology, *Atmos. Environ.* (submitted).
13. Cabada et al. (2003) Aerosol size-composition distributions during PAQS, *Atmos. Environ.,* (submitted).
14. Cabada et al. (2003) Fine particle light scattering reconstruction and measurements at PAQS, *J. Geophys. Res.*, (submitted).
15. Khlystov et al. (2003) In-situ continuous PM water concentrations measurements, (to be submitted).

Peer-Reviewed Publications (4)

INSTRUMENTATION

16. Subramanian et al. (2003) Sampling artifacts during measurement of ambient carbonaceous aerosol, *Aerosol Sci. Technol.,* (in press).
17. Stanier et al. (2003b) A method for the in-situ measurement of aerosol water content of ambient aerosols: The Dry Ambient Aerosol Size Spectrometer (DAASS), *Aerosol Sci. Technol.,* (in press).
18. Rees et al. (2003) The PM2.5 Federal Reference Method (FRM) and the chemical mass balance for fine particulate matter, *Atmos. Environ.,* (submitted).
19. Khlystov et al. (2003) Aerosol size distribution measurements from 3 nm to 10 mm: Instrument performance and particle properties, *Aerosol Sci. Technol.,* (in press).
20. Wittig et al.(2003) Semi-continuous PM2.5 inorganic composition measurements during the Pittsburgh Air Quality Study, *Atmos. Environ.* (submitted).

Peer-Reviewed Publications (5)

ATMOSPHERIC PROCESSES

21. Stanier et al. (2003a) Nucleation events during the Pittsburgh Air Quality Study: Description and relation to key meteorological, gas phase, and aerosol parameters, *Aerosol Sci. Technol.,* (in press).
22. Vayenas et al. (2003) Formation and removal of ammonium nitrate and its precursors: System responses to emission changes, (to be submitted).
23. Takahama et al. (2003) Evaluating the aerosol equibrium assumption in an urban area in the Northeastern US, *J. Geophys. Res.*, (submitted).
24. Zhang et al. (2003) Insights on nucleation burst and particle growth events in Pittsburgh based on Aerosol Mass Spectrometry, Environ. Sci. Technol. (in preparation).
25. Eatough et al. Meteorological influence on, and diurnal patterns in ambient fine particulate chemical composition at two sampling sites in metropolitan Pittsburgh: A 2001 intensive summer study, (in preparation).
26. Gaydos et al. (2003) Formation and removal of fine particulate matter in the Eastern US: The Eastern Supersites 2001 Intensive, (in preparation).

Our Next Steps

- Source characterization
  - Steel mill
  - Power plant
- Source attribution-Statistical modeling
  - Use of metals (daily and semi-continuous), organic tracers, size distributions, single particle mass spectrometer results
  - Use of individual and combined data sets
- Source attribution-Chemical transport modeling
  - July and January intensives
  - Evaluation with data from all projects
- Response of system to emission changes
  - Individual pollutants
  - Multi-pollutant strategies
- Synthesis
  - Role of power plants